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GENERAL BACKGROUND INFORMATION TO NOTES ON ECHOSTAR-DIRECTV MERGER SIMULATION ANALYSIS

U.S. Department of Justice
Antitrust Division

Economic Analysis Group Discussion Paper

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Simulation as an Alternative to Structural Merger Policy in Differentiated Products Industries

by

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Abstract

Public policy toward horizontal mergers has long been primarily structural, relying heavily on presumptions based on market shares, and eschewing any quantitative assessment of a merger's likely effects on price or welfare. As an alternative to structural presumptions in differentiated products industries, this essay proposes the estimation of the price and welfare effects of mergers constructed through simulations of the mergers within the context of tractable oligopoly models calibrated to the particular characteristics of the industry in question. Such simulations generally would be have to be highly simplified, and the estimates from them would therefore be rough. Nevertheless, they would provide a better basis for assessing the legality of a merger than do structural presumptions.

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1. Introduction

Public policy toward horizontal mergers, as embodied in the case law and in the Horizontal Merger Guidelines issued in 1992 by the U.S. Department of Justice and Federal Trade Commission, is primarily structural. Relevant markets are first delineated; market shares are assigned; and particular market shares and levels of market concentration give rise to presumptions of illegality. While the presumptions can be overcome and there is much more than this to merger analysis,[1] market delineation and market shares remain the heart and soul of horizontal merger policy. As the Supreme Court recently noted, "market definition generally determines the result of the case."[2]

Apart from presumptions from market shares, horizontal merger analysis consists of an assessment of the facts of each particular case with a view toward the likely effects of the merger on prices, outputs, and other dimensions of competition and welfare. This analysis may be insightful, but it is rarely quantitative. Rather, presumptions from market shares are supplemented primarily by the personal impressions and strongly held prior beliefs of enforcement officials, expert witnesses, and judges.

Economists (e.g., Chamberlin, 1950, 86–87; Hausman, Leonard, and Zona, 1992) have criticized reliance on market shares, particularly in differentiated products industries. But economists generally have not offered systematic, quantitative methods for predicting the effects of mergers,[3] and even conceptually simple approaches probably were not very practical until personal computers became ubiquitous and high-level programming languages like *Mathematica* were introduced.

This essay proposes a more quantitative approach to the analysis of mergers in differentiated products industries. Rather than begin with presumptions based on market shares, we suggest that the analysis of a merger begin with a simulation of its effects within the context of a tractable oligopoly model calibrated to the particular characteristics of the industry in question. Simple simulations are relatively easy to do and require little information beyond that required to compute market shares. Even if considered unrealistically simplistic, merger simulations provide a little light in a very dark place. If detailed information on the structure of demand is available, the methodology can be extended to more complex and more accurate simulations.

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[1] See generally Horizontal Merger Guidelines §§ 2–5.

[2] *Eastman Kodak Co. v. Image Technical Services, Inc.*, 504 U.S. 451, 469 n.15 (1992).

[3] Notable exceptions are Baker and Bresnahan (1984) and Hausman, Leonard, and Zona (1994), which are discussed in section 4.5 below. We also believe that the 1982 Merger Guidelines issued by the U.S. Department of Justice were a step in the right direction. They were a serious attempt to inject a measure of science and reproducability into structural merger analysis. See Werden (1983; 1992b, 190–205; 1993).

Most lawyers resist the use of scientific methods, both in directly predicting the effects of mergers and in the implementation of structural merger policy.

Section 2 discusses structural merger policy as it is applied to differentiated products industries and examines its shortcomings in general terms. Section 3 continues in the same vein by examining the standards of the Horizontal Merger Guidelines within the context of a model of differentiated oligopoly. Section 4 details simulation as an alternative to structural merger policy. A few concluding comments are contained in Section 5.

2. Shortcomings of Structural Merger Analysis

Structural merger policy as we know it was initially developed in three Supreme Court cases. The term "relevant market" was introduced in the *Columbia Steel* case in 1948, which also was the first horizontal merger case to focus on market shares.[4] The Court held the merger challenged in that case to be lawful, and congressional dissatisfaction with that result was a major factor precipitating amendment of the merger law in 1950.[5]

The basic principles followed by the lower courts today were laid out by the Supreme Court in the first two horizontal mergers cases decided on the merits by the Court under the 1950 amendments. In *Brown Shoe*, the Supreme Court held that market delineation is a prerequisite in horizontal merger cases, and it emphasized market shares in its analysis of the effects of the merger.[6] In *Philadelphia National Bank* the Court held that sufficiently high market shares establish the presumptive illegality of horizontal mergers.[7]

The Supreme Court has not had occasion to revisit these decisions, nor have the numerous lower court decisions over the last three decades greatly elaborated on these themes. The most influential elaboration on *Brown Shoe* and *Philadelphia National Bank* is that in the Horizontal Merger Guidelines. In Section 1.51, the Guidelines articulate general enforcement standards for horizontal mergers based on two measures of market shares and concentration—the "increase in the HHI," defined as twice the product of the pre-merger shares of the merging firms, and the "post-merger HHI," defined as the pre-merger Herfindahl-Hirschman Index (HHI)[8] for the relevant market plus the "increase in the HHI."

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[4] *United States v. Columbia Steel Co.*, 334 U.S. 495, 508, 512–13 & n.10 (1948).

[5] The *Columbia Steel* case arose under the original section 7 of the Clayton Act enacted in 1914. The Celler-Kefauver Act of 1950 amended the Clayton Act to prohibit mergers the effect of which "may be substantially to lessen competition . . . in any line of commerce in any section of the country." The latter two phrases were interpreted as meaning "in the relevant product and geographic market." See Werden (1992b, 129–30).

[6] *Brown Shoe Co. v. United States*, 370 U.S. 294, 334, 343 (1962).

[7] *United States v. Philadelphia National Bank*, 374 U.S. 321, 363 (1963).

[8] The HHI is the sum of the squares of all competitors' shares of a defined market. So that lawyers will not have to cope with decimals, the Guidelines express market shares in percentage terms, so the HHI falls between 0 and 10,000. For example, with just two competitors having shares of 30 and 70, the HHI would be $30^2 + 70^2 = 900 + 4900 = 5800$.

The Guidelines state that a merger falls within a safe harbor if the "post-merger HHI" for the relevant market is at most 1,000 or the "increase in the HHI" is at most 50. If the "post-merger HHI" exceeds 1,800, the Guidelines "presume that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power,"[9] but this presumption may be overcome by other factors discussed in later sections, including one on differentiated products.

Section 2 of the Horizontal Merger Guidelines makes an important contribution by laying out particular theories of possible anticompetitive effects from mergers and by articulating factors to be considered in evaluating both the relevance of each theory to any particular case, and the likely anticompetitive effect under each particular theory. The Guidelines separate the theories into two categories—"coordinated" and "unilateral." Unilateral effects are those arising from internalizing the direct competition between the merging firms in the profit-maximization calculus of the merged firm. For example, the price increase that results from the merger of competitors in a non-cooperative, price-setting oligopoly (see Deneckere and Davidson, 1985) is a unilateral effect. Thus, the familiar Bertrand, Cournot, and dominant-firm oligopoly models all reflect unilateral effects. Coordinated effects are other horizontal effects, such as the increased likelihood of some form of collusion.

Section 2.21 of the Guidelines discuss the unilateral effects of mergers in differentiated products industries. In it, the Guidelines state that a merger will be presumed to harm consumers significantly if the combined share of the merging firms is at least 35%.[10] One may infer that a merger will be presumed not to harm consumers significantly through unilateral effects if the combined share of the merging firms is below 35%.

What follows is concerned solely with the unilateral effects of merger in differentiated products industries. In differentiated products industries, we (Werden and Froeb, 1994, 1 n.1) consider coordinated effects to be of much less importance than unilateral effects.

2.1 Shortcomings Common to All Industries

Neither the case law nor the Horizontal Merger Guidelines explicitly link their market share presumptions to any measure of the effects of mergers on prices or welfare. Neither

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[9] There is an intermediate region between the two in which mergers are neither in a safe harbor nor does any presumption attach.

[10] The rationale for the 35% test is not explained in the Horizontal Merger Guidelines, but it appears to reflect a conscious decision to make the range of mergers subject to challenge on the basis of unilateral effects much narrower than the range of mergers subject to challenge on the basis of coordinated effects. We find this decision odd because we agree with Hay and Werden (1993) that noncooperative oligopoly models offer a far firmer basis for merger policy than does any notion of collusion. The rationale for using a standard based on the combined share of the merging firms most likely was that it permitted use of the 35% number that had appeared in prior editions of the Guidelines in a different context. In the 1982 and 1984 Merger Guidelines, there was a separate enforcement standard for mergers by large, leading firms, defined using the 35% test.

states any association between particular market shares and particular quanta of price and welfare effects, and neither articulates specific price increase or welfare decrease thresholds for illegality.[11]

Because horizontal merger policy is not based explicitly, even if indirectly, on likely price and welfare effects, it lacks potentially important reality checks. This is easily seen by contrasting the present situation with one in which particular price and welfare effects were explicitly associated with the market share thresholds. In the latter event, it would be possible to apply two useful checks on the validity of current market share presumptions. It would be possible to examine, theoretically and empirically, whether mergers at the thresholds are, in fact, likely produce the asserted price and welfare effects. And it would be possible to examine whether the asserted price and welfare effects really should trigger presumptive illegality.

The fact that presumptions of illegality are not explicitly based on predicted price and welfare effects also implies a failure to communicate in litigation about the legality of particular mergers. The various lawyers, expert witnesses, and judges may well have widely differing notions of the likely magnitudes of the price and welfare effects associated with particular merging firms' market shares. While one person may have in mind that given market shares are likely to be associated with a price increase of less than 1%, another may have in mind that the same shares are likely to be associated with a price increase of 50%.[12] In such circumstances, the discussion about relevant markets and shares that takes place in a trial is far less important than the discussion that may not take place about the implication of the markets and the shares.

It is also doubtful that current structural merger policy properly accounts for the basic elements of market structure. To whatever extent the merging firms' market shares are predictive of the price and welfare effects of mergers, the relationship is almost surely continuous, whereas market share presumptions basically just categorize shares as small or large. Additional points relating to the specific standards in the Horizontal Merger Guidelines are discussed in Section 3.

A third general problem with structural merger analysis is that there probably is no simple relationship between the merging firms' shares and effects on price and welfare. To the extent

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[11] It is possible that the market share presumptions used in the case law and in the Horizontal Merger Guidelines were predicated on an unstated relationship to particular price and welfare effects. There are two possible bases for such a relationship—empirical evidence and theoretical models. There is some empirical evidence indicating how the market shares of merging firms relate to price and welfare effects (see generally Werden, 1991). Within the context of many particular oligopoly models, it is relatively straightforward to examine the quantitative relationship between the shares of merging firms and the price and welfare effects.

[12] This is a not purely hypothetical problem. Our experience is that there are huge differences in prior beliefs among economists and lawyers working in antitrust, and they dramatically influence judgments.

that the relationship can be modeled or estimated in some way, it surely would be possible to enhance greatly the precision in merger analysis.

Finally, the fact that there are no explicit notions of price and welfare effects behind market share presumptions makes it impossible explicitly to tradeoff any efficiency effects of mergers that can be demonstrated and quantified. Without quantification of anticompetitive effects, there is no way in which to ascertain whether such effects are sufficient to outweigh a specified reduction in marginal or fixed costs for the merged firm.

2.2 Problems Particular to Differentiated Products Industries

Because of the critical role played by market share presumptions in merger law, the central focus of merger litigation commonly is market delineation and market shares. Typical characteristics of differentiated products, and consumer preferences over them, provide much room for argument about market boundaries and at the same time make such arguments a particularly fruitless exercise.

Different products generally are not tightly clustered in terms of prices and various product attributes; rather, products appear over a broad and fairly continuous range. Moreover, consumers have complex and differing subjective preferences with respect to price and other product attributes. Not only do consumers differ with respect to first choices, consumers making the same first choices may differ on second and third choices. Competition is somewhat localized, because second- and third-choice products for most consumers are similar in price and product attributes to their first-choices. On the other hand, competition is not entirely localized, in that the second- and third-choice products for some consumers are not particularly similar in product attributes to their first choices.

One implication of these characteristics is that any relevant market delineated by reference to substantial gaps in the chain of substitutes likely would be exceptionally broad. This provides defendants with an opportunity to argue for a very broad relevant market, because there is support in the case law[13] and economic literature[14] for the proposition that no meaningful boundaries can be drawn within a price and quality continuum.[15] This argument may apply to undifferentiated products as well, since spatial and other product differences also

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[13] In *Brown Shoe Co. v. United States*, 370 U.S. 294, 326 (1962), the Supreme Court held that "[w]here the antitrust plaintiff articulates product differences along a spectrum of price and quality, the product market distinctions are economically meaningless." A few other cases are similar.

[14] This view was espoused by Robinson (1969, 17) and more recently by Schmalensee (1982, 1799–800).

[15] Defendants may cases take the opposite tack, arguing for such narrow markets that the merging firms are not even in the same market. As explained by Werden (1992a, 117–18), this argument often has more merit that the broad market argument actually used, particularly under the Horizontal Merger Guidelines, but it is seldom used.

may present a continuum; however, it is particularly strong with differentiated products for a variety of reasons.

First, differentiated products nearly always present a price and quality continuum, whereas undifferentiated products typically exhibit significant breaks in the chain of substitutes, at least with respect to the product dimensions of the market. Second, differentiated products tend to have multiple quality attributes, each of which may present a continuum. Third, a differentiated product is likely to compete, at least to a limited extent, directly with products that are not adjacent along the continuum of any of the product's attributes. That is, a given consumer may consider practically anything to be the next-best substitute for any particular product. Finally, a broad range of products are likely to be functionally substitutable (e.g., all beverages, including tap water, are functionally substitutable for any particular brands of soft drinks or malt beverages), and the subjective consumer preferences that limit actual substitution are difficult to prove in court. Speculation about preferences, even well informed speculation by market participants, tends to lack the clarity, consistency, and scientific validity that are the hallmarks of totally convincing evidence.

The purpose of advocating a very broad market delineation, of course, is to produce very small market shares, and the importance of market share presumptions gives defendants a powerful incentive to argue for broad markets. Defendants have responded to this incentive, for example, by asserting that the relevant market for a soft drink merger included all beverages.[16] What is likely to be overlooked in this process is the critical fact that small market shares are meaningless if markets are delineated very broadly. What matters is not share in some arbitrary market, but rather how often the product of either merging firm is viewed by consumers as the next-best substitute of the other merging firms, and how close the third-best substitute is in such cases. The preoccupation with market delineation and shares may cause the real issues to be overlooked.

Plaintiffs—government and private—also play the market delineation game. If the merging firms are particularly close in product space, a narrow market delineation will yield very high market shares, so there is a strong incentive to delineate a very narrow market, particularly in light of the Horizontal Merger Guidelines' 35% rule. Plaintiffs have responded to this incentive by advocating, for example, that the relevant market for a candy merger was "gift boxed chocolates sold nationally through chain drug stores and mass marketers."[17]

A narrow market delineation often is supported by the market delineation principles of Sections 1.1 and 1.2 of the Guidelines, which define a market as a group of products and associated geographic area within which a profit-maximizing monopolist would raise price significantly. The Guidelines' Smallest Market Principle further states that the relevant market

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[16] *Federal Trade Commission v. Coca-Cola Co.*, 641 F. Supp. 1128, 1133 (D.D.C. 1986).

[17] *Pennsylvania v. Russell Stover Candies, Inc.*, 1993-1 Trade Cas. (CCH) ¶ 70,224 at 70,090 (E.D. Pa. 1993).

generally is the smallest group of products and area that constitute a market.[18] The Guidelines' definition of a market does not preclude the delineation of a narrow market within a broad price and quality continuum because a monopolist might be able to exercise significant market power in just a small portion of the continuum, and if so, the Guidelines' Smallest Market Principle may require a narrow market delineation.

If markets are to be delineated and market share presumptions are to be used, the Guidelines' approach surely is preferable to the delineation of very broad markets in which market shares are sure to be meaningless. However, shares of a Guidelines market still tell little of the story. There will always be some competition at the margin, and it must be accounted for in a proper analysis of the likely competitive effects of a merger. More importantly, the key to a proper competitive analysis of a differentiated products merger is a careful consideration of the competition between the merging firms, and market shares do not necessarily indicate much about that.

3. The Specific Structural Standards of the Horizontal Merger Guidelines

To examine the utility of the specific structural standards of the Horizontal Merger Guidelines, it is useful to postulate a particular model of oligopoly and, especially, a particular demand system. We postulate that the oligopoly equilibrium is noncooperative in price and specify a logit demand system. The assumption of logit demand certainly is arbitrary, but by no means unprecedented. Willig (1990, 299–304) used logit demand to motivate the use of market share presumptions for differentiated products mergers. He considered the logit model to be a base case in the sense that the merging firms are neither especially close in product space nor especially far apart. Willig was one of the principal authors of the 1992 Horizontal Merger Guidelines, and the differentiated products section of the Guidelines appears to reflect his analysis.

3.1 The Antitrust Logit Model[19]

A logit demand system can be motivated in several distinct ways (see Anderson, de Palma, and Thisse, 1992, chs. 2, 5; Werden, Froeb, and Tardiff, forthcoming). With logit demand, the choice probabilities, P_j, have the form

$$\exp(\alpha_j - \beta p_j) / \Sigma_{k \in C} \exp(\alpha_k - \beta p_k), \tag{1}$$

where p_j is the price of good j, α_j is a parameter summarizing generally perceived quality

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[18] The Guidelines' approach to market delineation is discussed in detail by Werden (1983, 1992b, 1993). The application to a continuum of differentiated products is discussed by Werden and Rozanski (1994).

[19] The material discussed in this section is treated in much greater detail by Werden and Froeb (1994) and Werden, Froeb, and Tardiff (forthcoming). The actual merger simulations are conducted using a *Mathematica* program, detailed by Froeb and Werden (forthcoming).

differences among products, β is a parameter indicating the sensitivity of choices to prices, and C is the set of possible choices.

Following Werden, Froeb, and Tardiff (forthcoming), we use the Antitrust Logit Model (ALM), which expresses the foregoing in traditional antitrust terms. Product n is defined to reflect the choice of "none of the above," i.e., to be an "outside good," and it is assumed that $p_n \equiv 0$ to make the utility of the outside good a constant. The choice probabilities for the "inside goods" (i.e., those other than the outside good), conditional on the choice being an inside good, are termed "shares" and denoted s_j. The aggregate elasticity of demand for the inside goods (defined to be positive) is denoted ε. Defining $\overline{p}$ as the share-weighted average pre-merger price for the inside goods, Werden and Froeb (1994, 410) have shown that equation 1 implies

$$\varepsilon = \beta \overline{p} P_n. \tag{2}$$

The own-price and cross-price elasticities of demand, ε_j and ε_{jk}, are

$$\varepsilon_j = \beta p_j (1 - P_j) = [\beta \overline{p}(1 - s_j) + \varepsilon s_j] p_j / \overline{p} \tag{3}$$

$$\varepsilon_{jk} = \beta p_k P_k = s_k (\beta \overline{p} - \varepsilon) p_k / \overline{p}. \tag{4}$$

As is clear from equation 4, β controls the degree of substitutability among the inside goods.

The simplest version of the ALM further assumes that: each product is initially sold by a single firm; each firm has constant marginal cost, c_j; and fixed costs are sufficiently low that no firms shut down in equilibrium. It also assumes that firms compete by setting prices noncooperatively both pre- and post-merger. Anderson, de Palma, and Thisse (1992, 264–66) have proved the existence and uniqueness of equilibrium in a noncooperative, price-setting oligopoly with logit demand.

In logit models, the effect on consumer welfare of a change in any argument of the utility function is calculated as the compensating variation necessary to restore consumers to the original level of utility. As shown by Small and Rosen (1981), the change consumer welfare loss from changing prices from $\{p_j^0\}$ to $\{p_j^1\}$ is given by

$$\left[\ln \textstyle\sum_j \exp(\alpha_j - \beta p_j^1) - \ln \sum_j \exp(\alpha_j - \beta p_j^0)\right] \beta^{-1}. \tag{5}$$

Total welfare is defined in the conventional manner as consumer welfare plus profits.

Werden and Froeb (1994) show that implications of this model are: The prices of all products in the industry increase as a result of a merger, but the magnitudes of the price increases are very different for different products. If the merging firms are of different size, their merger has asymmetric effects on their prices; the price of the smaller-share product increases more, typically much more, than that of the larger-share product. In addition, the merged firm typically increases the weighted average of its two prices much more than any nonmerging firm increases its price. Larger nonmerging firms increase price more than smaller ones, so increased concentration among the nonmerging firms increases the price effect of a merger, but the effect is typically fairly weak.

Since all prices increase, it follows from equation 5 that consumer welfare decreases as a result of a merger; however, Froeb, Tardiff, and Werden (1994) show that total welfare may be enhanced by a merger. Welfare gains can arise because a merger causes a shift in production from merging firms to nonmerging firms. If small or medium-sized firms merge, there is a shift in production to larger firms. In this model, larger firms necessarily have both lower costs and more preferred products, so total welfare may increase as a result. Welfare gains also can arise because a merger causes a shift in production from one merging firm to the other. The merger of a large firm with a smaller firm causes a shift in production from the smaller merging firm to the larger, which has lower costs and more preferred products, and total welfare may increase as a result. While either of these effects may cause a merger to produce a net increase in welfare, that is far more likely with the former effect.

For an industry consisting of firms of roughly the same size, there is so little potential for gain by shifting production that all mergers lessen welfare—even if the industry is unconcentrated. For an industry with considerable asymmetry of firm sizes and efficiencies, however, there is a significant potential for gain by shifting production. Considerable asymmetry of firms sizes is likely to entail substantial concentration; thus, mergers in concentrated industries are much more likely to enhance welfare than mergers in unconcentrated industries.

3.2 The Standards of the Horizontal Merger Guidelines in Light of the ALM

Within the context of the ALM, it is possible to address the following questions relating to the structural standards in the Horizontal Merger Guidelines: Is the combined share of the merging firms, as used in the 35% rule, a useful predictor of price and welfare effects? Is the product of the shares of the merging firms, as used in the "increase in the HHI" screen, a useful predictor of price and welfare effects? Is the concentration of the nonmerging firms, as reflected by the "post-merger HHI" screen, a useful predictor of price and welfare effects? Do structural indicators alone adequately predict the price and welfare effects?

In addressing these questions, the following notation is useful:

ΔH ≡ the "increase in the HHI,"
twice the product of the pre-merger shares of the merging firms

H_{nm} ≡ the pre-merger HHI for the nonmerging firms,
defined over just the universe of nonmerging firms

s_m ≡ the pre-merger combined share of the merging firms

Δp_m ≡ the share-weighted average percentage price increase
for the merging firms as a result of the merger

Δp_{ind} ≡ the share-weighted average percentage price increase
for the industry as a result of the merger

ΔCW ≡ change in consumer welfare as a result of the merger
as a percentage of pre-merger revenue

ΔW ≡ change in total welfare as a result of the merger
as a percentage of pre-merger revenue

Since the Horizontal Merger Guidelines' 35% rule places great weight on s_m, we begin in Table 1 by varying s_m, holding constant both ΔH and distribution of shares among the nonmerging firms (but not the "post-merger HHI").[20] For illustrative purposes, ΔH is 300, and H_{nm} is 2,000 (5 equal-sized nonmerging firms). We find that the industry-wide price effects of the merger, as reflected in both Δp_{ind} and ΔCW, are nearly the same for all of the mergers. Increasing s_m increases total welfare loss somewhat, but it decreases Δp_m. Thus, s_m appears worthless as a predictor industry-wide price effects or consumer welfare and actually gets things backward as a predictor of the merging firms' price increase.

Table 1. Price and Welfare Effects of Illustrative Mergers Varying Only s_m

s_m	Δp_m	Δp_{ind}	ΔCW	ΔW
25	2.16	0.54	–0.56	–0.14
30	1.77	0.54	–0.57	–0.16
35	1.50	0.54	–0.57	–0.18
40	1.31	0.53	–0.58	–0.19
45	1.16	0.53	–0.59	–0.21

Note: For all mergers it is assumed that all pre-merger prices equal one, $\beta = 5$, $\varepsilon = 1$, and there are 5 nonmerging firms with equal shares. To two decimal places, the respective market shares of the merging firms are (15, 10), (23.66, 6.34), (30, 5), (35.81, 4.18), and (41.38, 3.63).

In addition to the special standard applied to differentiated products industries, the Horizontal Merger Guidelines rely on ΔH and on the "post-merger HHI." We examine their relationships to the four measures of price and welfare effects in Tables 2 and 3. In Table 2, we vary ΔH, holding constant both s_m and the distribution of shares among the nonmerging firms. For illustrative purposes, s_m is 35%, and there are two identical nonmerging firms (making H_{nm} 5,000 and the "post-merger HHI" 3,337.5). Remarkably, Δp_m, Δp_{ind}, ΔCW, and ΔW are almost exactly proportional to ΔH.

[20] The logit merger simulations do not involve market delineation as such, but the implicit market delineation falls between the very broad market delineation that defendants likely would advocate and the very narrow market delineation that plaintiffs likely would advocate. For most of the simulations, the assumed elasticity of demand for the inside goods is 1, which might be a plausible elasticity of demand for all soft drinks or all brands of beer. Defendants might argue that the relevant market was all beverages, in which demand likely would be highly inelastic, while plaintiffs might argue that the relevant market is just colas or premium beers, in which demand likely would be elastic.

Table 2. Price and Welfare Effects of Illustrative Mergers Varying Only ΔH

ΔH	Δp_m	Δp_{ind}	ΔCW	ΔW
100	0.48	0.20	–0.22	–0.04
200	0.99	0.41	–0.44	–0.09
300	1.52	0.62	–0.66	–0.14
400	2.09	0.84	–0.88	–0.19
500	2.68	1.06	–1.11	–0.24
600	3.31	1.29	–1.33	–0.29

Note: For all mergers it is assumed that all pre-merger prices equal one. $\beta = 5$, $\varepsilon = 1$, and there are two nonmerging firms with equal shares. To two decimal places, the respective market shares of the merging firms for the six mergers are (33.41, 1.49), (31.86, 3.14), (30, 5), (27.81, 7.19), (25, 10), and (20, 15).

Table 3. Price and Welfare Effects of Illustrative Mergers Varying Only H_{nm}

H_{nm}	Number of Nonmerging Firms	Δp_m	Δp_{ind}	ΔCW	ΔW
1,000	10	2.15	0.52	–0.54	–0.16
2,500	4	2.16	0.56	–0.58	–0.13
3,600	4	2.16	0.60	–0.62	–0.12
5,000	2	2.18	0.67	–0.68	–0.09
6,800	2	2.19	0.77	–0.79	–0.09

Note: For all mergers it is assumed that all pre-merger prices equal one, $\beta = 5$, and $\varepsilon = 1$. Among the nonmerging firms, the shares are equal in first, second, and fourth rows. In the third row, nonmerging firms have shares of 37.5, 22.5, 7.5, and 7.5. In the fifth row, the nonmerging firms have shares of 60 and 15.

In Table 3, we vary H_{nm}, holding constant both ΔH and s_m. The relevant variable is H_{nm}, rather than the "post-merger HHI," because the "increase in the HHI" is a component of the "post-merger HHI," and we want to assess the independent predictive power of the "post-merger HHI." The shares of the merging firms are assumed to be 15% and 10%, yielding an s_m of 25% and a ΔH of 300. Δp_m is roughly the same for all of the mergers, but Δp_{ind} and ΔCW are somewhat greater for more concentrated distributions of the nonmerging firms because larger nonmerging firms increase price more as a result of a merger. This is true both when the number of firms is changed, holding the variance constant (compare rows 1, 2, and 4), and when the variance of shares is changed, holding the number of firms constant (compare rows 2 and 3, and rows 4 and 5). Nevertheless, the effect of H_{nm} on Δp_{ind} or ΔCW is fairly modest. Because varying H_{nm} has relatively little effect on ΔCW, the effect of H_{nm} on ΔW is driven primarily by cost effects. With H_{nm} greater than about 1,000, industry average cost falls a

result of the mergers, and this cost effect is relatively large. Consequently, greater concentration among the nonmerging firms reduces the welfare loss from a merger.

The foregoing exercises suggest that the "increase in the HHI" is a far better predictor that either the combined share of the merging firms or the "post-merger HHI." This conclusion can be reinforced by consideration of randomly generated mergers in which s_m, ΔH, and H_{mm} all vary simultaneously.[21] Details of the simulation results are reported by Werden and Froeb (1993, 9–10). In a nutshell, they show that ΔH is far better predictor of both measures of price and both measures of welfare than is s_m or H_{mm}, and that ΔH alone predicts price and welfare effects nearly as well as is ΔH combined with s_m and H_{mm}.

The overall conclusion from these illustrations is not so much that the "increase in the HHI," as used in the Horizontal Merger Guidelines, is a good predictor, but that the other two structural standards used by the Guidelines are not such good predictors and add very little to what is indicated by the "increase in the HHI" alone. Apart from the impact of the "increase in the HHI," the "post-merger HHI" has little effect on either the price effects or the welfare effects of mergers in logit oligopoly. On the other hand, it is certainly the case that a merger is highly unlikely to have serious adverse effects if the "post-merger HHI" is below 1,000, the safe harbor level in the Guidelines. Requiring that the combined shares of the merging firms exceed 35% is not supportable in light of the foregoing. To the extent that there should be a threshold for challenging mergers expressed as a function of the merging firms' shares, that threshold should be in terms of the "increase in the HHI."

The foregoing is more useful in comparing the relative performance of the three market share and concentration standards in the Horizontal Merger Guidelines than it is in indicating the absolute predictive power of any or all of those standards, because it has been assumed that β and ε were known and constant. There remains the question of how well the market share and concentration standards of the Guidelines predict when values of the demand elasticity parameters are neither constant nor known. This, of course, is the state of the world with which merger policy must contend. To explore this question, we consider a thousand merger

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[21] For each merger simulation, a random number generator selects the number of firms in the industry from a discrete, uniform distribution of integers from 4 to 10 and selects outputs from a continuous, uniform distribution over the interval [0, 1]. The outputs are converted into market shares by dividing each by their sum. We assume that all pre-merger prices equal one, $\beta = 5$, $\varepsilon = 1$, and the merging firms are the first two generated. These parameter values are comparable to estimates we have seen for actual industries.

In the simulations, the median ΔH is 326; the median H_{mm} is 2,689; and the median s_m is 29.8. The simulations also produced a considerable range in all of the measures of market shares and concentration. Since all the simulations have at most ten firms, none is in the Horizontal Merger Guidelines' safe harbor associated with a "post-merger HHI" below 1,000, but 11.6% fall in the safe harbor by virtue of an "increase in the HHI" of less than 50. For 80.4% of the simulations the "increase in the HHI" exceeds 100.

simulations in which a random number generator selects β from a continuous, uniform distribution over the interval [2, 10] and ε from the interval [.5, $\beta - 1$].

Table 4 indicates the proportion of variance in the price or welfare measures explained by the corresponding index of market shares or concentration. It suggests that ΔH is, at best, a mediocre predictor of both measures of price and both measures of welfare, while s_m and H_{mm} are substantially worse predictors.

Table 4. Percentage of Variation in Price and Welfare Explained by s_m, ΔH, and H_{mm}

	Δp_m	Δp_{ind}	ΔCW	ΔW
ΔH	.421	.567	.562	.613
H_{mm}	.155	.253	.254	.241
s_m	.352	.461	.463	.476

Figure 1 provides a more graphic indication of the predictive power of ΔH in absolute terms. Based on the thousand simulations, it gives approximate, empirical 95% confidence intervals for Δp_{ind} and ΔW given ΔH. Figure 1 conveys two obvious but important messages.

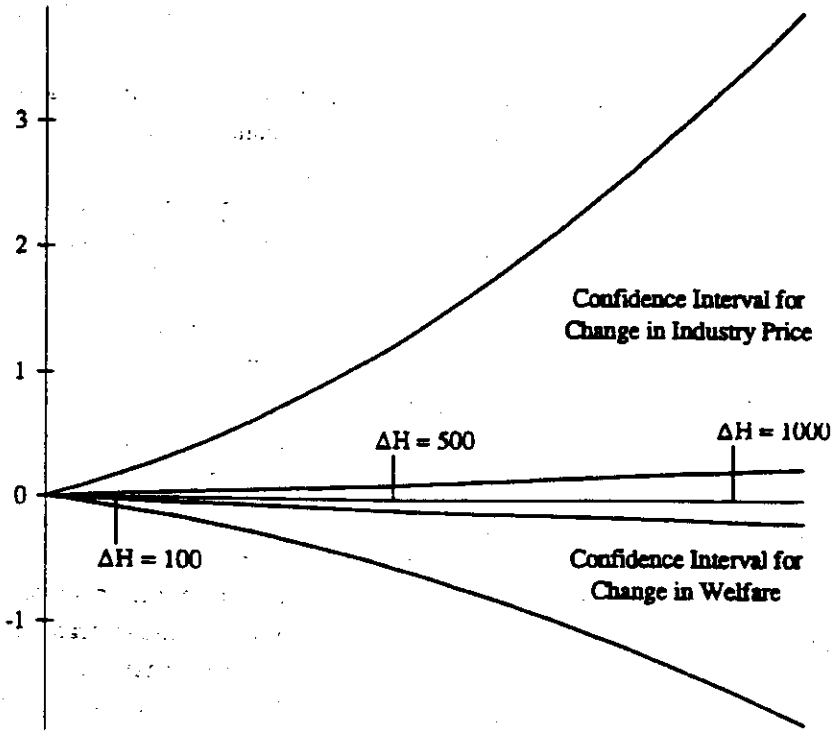

Figure 1. 95% Confidence Intervals for Change in Industry Price and Change in Welfare

First, mergers that are relatively small, but nevertheless trigger the presumption in the Guidelines created by the "increase in the HHI" of at least 100, are likely to be associated with trivial price and welfare effects. Indeed, these effects are so small that the Guidelines' "increase in the HHI" threshold of 100 makes sense only if one believes either that mergers are likely to generate no efficiencies or that only consumer welfare should be considered in merger cases. The 35% rule could be justified as requiring larger mergers to trigger the presumption, since a combined share for the merging firms of 35% typically translates into an "increase in the HHI" of 400–500. Of course, it would have been better to specify that the presumption of illegality attaches when the "increase in the HHI" exceeds 400 or 500.

Second, large mergers, which may have significant price and welfare effects, exhibit an extraordinarily large variance in effects. Trivially small effects are possible, as are quite substantial ones. Thus, there is an acute need for a method of predicting merger effects that can narrow the range of uncertainty.

4. Simulating Mergers in Differentiated Products Industries

Rather than begin the analysis of differentiated product mergers with market delineation and market shares, we suggest beginning with simulations. Within the context of a specified demand system, it is straightforward to simulate the unilateral effects of differentiated products mergers by fitting the model to the pre-merger equilibrium and then computing the post-merger equilibrium.

We recognize that simulations are by no means perfect predictors of price and welfare effects. Particularly if logit demand is arbitrarily assumed, simulations generally can provide only crude estimates of price and welfare effects. These estimates should be supplemented with whatever other information and insights are available. The point of the simulations is to provide a quantitative starting point for analysis which could be shared by all involved in the debate of a merger's effects.

Simulations are particularly useful in differentiated products industries partly because structural analysis is particularly unhelpful in such industries. Simulation avoids the extreme in-or-out dichotomy inherent with market delineation and market shares. It accounts for both competition from outside the specified choice set and for the fact that competition within the specified choice set is asymmetric because of perceived differences in product attributes.

Simulation makes it not only possible, but relatively simple, to trade potential efficiencies off against anticompetitive effects. If a merger would be expected to reduce one merging firm's marginal cost, then the simulations of the post-merger equilibrium can incorporate that assumption. Estimates of fixed cost savings could even more easily be incorporated into the welfare calculations. It is even possible to examine entry-related issues by assessing the extent to which the price and profit increases for various firms in the industry create an opportunity for entry, and by examining the effect of entry on the price and welfare effects of a merger.

4.1 Simulating Mergers with the ALM[22]

To perform a simulation, it is necessary to specify a demand system. We specify the logit model, as detailed above. Logit demand is a highly useful assumption because it permits great parsimony. All that is required to conduct simple simulations are prices, quantities, the aggregate industry demand elasticity, ε, and a parameter, β, controlling cross elasticities of demand within an industry. These demand elasticity parameters can be estimated or guessed at in a pinch.[23] Firm-specific demand and cost parameters can be inferred by assuming that the pre-merger equilibrium was generated by a one-shot, non-cooperative, price-setting game. Werden, Froeb, and Tardiff (forthcoming) also argue that the logit assumption can be motivated as a diffuse prior on substitution patterns, in that unknown second and subsequent choices are assumed to be patterned just as known first choices.

The ALM is used to predict the price and welfare effects of mergers in three steps. First, the two demand parameters are estimated or guessed at. Second, the first-order conditions for equilibrium pre-merger are solved for the implied marginal costs, and the logit probability functions are solved for the implied values of the α_j's. Third, the first-order conditions for equilibrium post-merger are solved for prices and outputs.

With the simple logit model discussed above, step two is quite simple. Differences among the α_j's are all that matter, and they are unaffected by the arbitrary choice of one of them. Thus, α_n is set equal to an arbitrary constant, and the α_j's for the inside goods are calculated by taking the logs of the ratios of π_j to π_n, substituting, and rearranging. It is easy show that

$$\alpha_j = \alpha_n + \beta p_j + \ln s_j + \ln(\beta\overline{p}/\varepsilon - 1). \qquad (6)$$

Given prices, shares, and the two elasticity parameters, each of the first-order conditions for profit maximization can be uniquely, albeit numerically, solved for the implied value of c_j.

4.2 Estimation of Logit Models

Estimation of the logit β from the sort of grouped time-series data likely to be most readily available is quite straightforward. From equation 1 it follows that β can be estimated by designating one product as the numeraire, and regressing the log of shares relative to the

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[22] It is also possible to use a more complicated versions of the ALM. The use of the nested logit model, which allows differing substitution patterns within the choice set and adds one or more additional parameters, is discussed by Werden and Froeb (1994) and Froeb, Tardiff, and Werden (1994). Froeb, Tardiff, and Werden (1994) also incorporate product characteristics other than price into the estimated demand system and examine how exogenous changes in competitive conditions change the price and welfare effects of mergers. The logit assumption can be tested, and demand systems other than the logit can be used, of course.

[23] Experienced economists should be able to make reasonable guesses at ε (although plaintiffs and defendants might make quite different guesses). Guessing at β may appear to present a problem, because economists have little familiarity with it. However, a full set of own and cross elasticities are implied by ε and β through equations 3 and 4, so the experience comparable to that drawn on in guessing at ε also provides a check on the guess at β.

numeraire on prices minus the numeraire price. Each product (other than the numeraire) presents a time series from which β could be estimated, but all should be pooled in the estimation.

Maximum likelihood (ML) estimation of the logit β from individual data was developed by McFadden (1974, 113–30), who demonstrated that, under very general conditions, the ML estimators are asymptotically efficient and normally distributed. Useful discussions of ML estimation of logit models are provided by Amemiya (1985, 295–96), Ben-Akiva and Lerman (1985, 118–19), Maddala (1983, 73–75), McFadden (1974, 115; 1984, 1406–10), and Train (1986, 44–47).

The logit model can be estimated with just data on actual first choices, but data on individuals' rankings of choices can be used to get a more precise estimate of the parameters (see Beggs, Cardell, and Hausman, 1981). The use of choice rankings may be particularly attractive when it is relatively costly to sample individuals but relatively cheap to elicit a ranking of their choices when they are sampled. For example, in the Froeb, Tardiff, and Werden (1994) study, individuals were asked to rank long-distance carriers given a hypothetical vector of prices.

As a general matter, demand estimation presents the basic econometric problem that prices are endogenous. Several different estimation strategies can be used to recover demand parameters in a qualitative choice context with endogenous prices. The most common involves the use of cost shifters as instruments. As an alternative, Berry (1994), and Berry, Levinsohn, and Pakes (1995) estimate "inverted" share equations by instrumental variables. In a noncooperative Bertrand equilibrium, a change in a product's demand elasticity leads to a change in its price, so anything that shifts a product's demand elasticity, but is uncorrelated with unmeasured quality, can act as an instrument for price.

Hausman, Leonard, and Zona (1994) exploit within-choice variation across cities to identify price elasticities, using as instruments for price in any given city, the prices in other cities. An advantage of this approach is that it permits the use of high-frequency, supermarket, scanner data without the need for additional instruments, such as cost components. A disadvantage is the assumption that demand shocks are independent across metropolitan areas. For goods with large seasonal variation in demand, or with national advertising campaigns that affect various cities at the same time, this assumption is likely to be violated.

Froeb, Tardiff, and Werden (1994) use within-choice variation in price to estimate price elasticities of demand for long-distance carriers. Sampled consumers were asked which of three long-distance carriers they would prefer at hypothetical prices. Surveying consumers about the choices they would make at different hypothetical prices has two advantages. First, price is allowed to vary experimentally across consumers, so there is no endogeneity problem. Second, price can be made to vary in any relevant range, so that answers to questions like "how much will price rise following a merger?" can be answered without having to extrapolate

outside the sample. The disadvantage is that the surveyed preferences may not correspond well to actual behavior.

4.3 Illustrative Merger Simulations

Werden and Froeb (1994) simulate the price and welfare effects of hypothetical mergers of actual U.S. long-distance carriers, using estimates of both elasticity parameters from other sources. A striking feature of their results is the substantial asymmetry of the price increases between the two merging firms and between the merging and nonmerging firms. For the mergers involving firms of very different size, the smaller merging firm increases price at least several times as much as the larger merging firm. For all of the mergers, the nonmerging firms increase price by a fraction of the amount that the larger merging firm increases price. Also interesting is that mergers not involving AT&T lessen total welfare very little; even the merger of MCI and Sprint reduces total welfare by less than .05% of pre-merger revenues.

Werden and Froeb also consider a nested-logit specification with the non-AT&T carriers in a nest. With this specification, mergers not involving AT&T have less of an anticompetitive effect and actually enhance welfare. They also consider the possibility that the cost advantages of large firms can be extended through merger. They find that when a merged firm is assumed to have the lower of the two marginal costs of the merging firms, all of the mergers enhance welfare except that of AT&T with MCI, although the welfare gains are all small.

Froeb, Tardiff, and Werden (1994) conduct a similar exercise for long-distance carriers in Japan. They use an estimate of ε from a published source and estimate β using data from a survey of residential customers. The structure of the industry in Japan is similar to that in the United States before the break-up of AT&T, with NTT being a dominant firm with over 85% of the residential business and other carriers disadvantaged by not having equal access to local telephone subscribers. With greater firm asymmetry than in the United States, they find even greater asymmetry in the price effects from merger. For the mergers involving NTT, its merger partner increases price more than 10 times as much as NTT. The nonmerging firms increase price by a fraction of the amount that the smaller merging firm does, and by less than 1% as much in several cases. Mergers involving NTT reduce total welfare, while mergers not involving NTT enhance total welfare, if only slightly.

Froeb, Tardiff, and Werden also consider how the effects of the mergers would be different with more equal access. Premerger prices and market shares cannot be observed in this case, but rather are predicted using the estimated logit demand system. They find that more equal access increases the welfare loss associated with mergers involving NTT and generally decreases the welfare gain associated with the other mergers. This occurs in large part because substitution to NTT resulting from the mergers produces less of a welfare gain with more equal access. It is notable that more equal access reduces market concentration yet makes the mergers more of a problem.

Feldman (1994) simulates the price and welfare effects of the actual merger of two HMOs in Minneapolis, which occurred in 1992. The two HMOs accounted for half of HMO

enrollment in the area. Feldman specifies a nested-logit demand structure, with different types of health plans separated into two nests. He uses estimates of the demand parameters from his own prior research.[24] Feldman reports widely ranging estimates of margin increases, reflecting the fact that the merging plans were more important to some employers than others. For the one employer offering HMOs of just the merging firms, he estimates price increases of about 19%.

4.4 Insights into Logit Simulations Gleaned from Experience

Logit merger simulations do not involve explicit market delineation; however, the implicit market delineation associated with specification of the inside goods matters in three ways: (1) prices of inside goods are set through the noncooperative equilibrium simulated by the model, while prices of outside goods are held constant; (2) cross elasticities of demand among inside goods are constrained by the logit assumption, while cross elasticities of demand between the inside goods and outside goods are unconstrained; and (3) profits associated with inside goods are included in total welfare, while profits associated with outside goods are not.

Inside goods and outside goods may exert equally important constraining effects on the prices of the merging firms, so limiting the set of inside goods does not assume away important competition from the outside goods. It is essential, however, that the demand parameters used in the simulations be estimated for the set of inside goods actually used. Narrowing the set of inside goods normally increases the aggregate elasticity of demand for those goods.

Apart from obviously poor substitutes, three types of products are good candidates for exclusion from the inside goods. First, it is safe to exclude minor products (e.g., those accounting for less than five percent of consumption) because their prices will be affected hardly at all by a merger. Excluding them treats them as a competitive fringe within which prices are constant. This treatment may be sensible *a priori* and will have virtually no effect on the predicted price increases for the merging firms.

Second, it may be best to exclude products believed to be particularly good substitutes for each other but not for the products of the merging firms. This situation is inconsistent with the substitution pattern implied by the logit model, and excluding the products is much easier than using a model that more accurately reflects the true substitution patterns.

Finally, it may be best to exclude products selling at such low prices that the simulations infer them to have negative marginal costs. When minor products have negative inferred marginal costs, the reason is either that they face particularly good substitutes, contrary to the logit assumption, or, more likely, that they are being priced in a manner inconsistent with static

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[24] Feldman's approach differs somewhat from that described above. Since HMOs can price discriminate, Feldman estimates separate effects for each of the six firms that had offered both of the merging HMOs. Feldman also does not solve for marginal costs but rather expresses the model in terms of markups, and he uses premerger quantities predicted by the model rather than actual premerger quantities.

noncooperative price setting (e.g., penetration pricing). In either event, excluding the products certainly causes the model to better fit the data, and this may make its predictions seem more plausible.

Confidence intervals on the price and welfare effects can be calculated in a straightforward manner to reflect uncertainty about one or both of the demand elasticity parameters. Some caution must be exercised, however, since total welfare is not monotonic in ϵ. Experience also indicates that the predictions of the simulations may be much more sensitive to changes in ϵ than to changes in β. On the other hand, if β (more precisely $\beta\bar{p}$) is very large or very small, the effect of a merger is slight. When β is very large, the effect of a merger is slight because the inside goods not involved in the merger are very good substitutes for those of the merging firms. When β is very small, the effect of a merger is slight because the products of the merging firms are not very good substitutes for each other.

4.5 Alternatives to Simulations

An alternative to merger simulations is to estimate the relevant demand elasticities and calculate the post-merger equilibrium from first-order conditions, assuming that all of the relevant elasticities are invariant to the price and quantity changes resulting from a merger. However, this assumption is unlikely to hold. Most often, increasing the price for a product increases the elasticity of its demand. There is a strong tendency for this to occur, because the price increase induces a quantity decrease, and both of these effects tend to increase the demand elasticity. If the elasticity of demand does increase as price is increased, assuming the contrary leads to an overestimate of the price increases from mergers, probably by quite a lot. Froeb and Werden (1992) explore this phenomenon, and illustrate its significance.

The leading example of the elasticity-estimation approach is Baker and Bresnahan (1985), who calculate the price effects of several beer mergers using estimated residual demand elasticities. Their approach assumes constant elasticities and that the merged firm acts as a Stackelberg leader. To illustrate the potential for error that arises in their approach from the assumption of constant elasticities, consider the hypothetical merger of AT&T with MCI, for which Werden and Froeb (1994) estimate price and welfare effects assuming logit demand. Applying the Baker-Bresnahan approach to the elasticities presented by Werden and Froeb yields percentage price increases of 48.6 for AT&T and 101.8 for MCI. These estimates exceed those calculated in Werden and Froeb's (1994, Table 3) logit simulations by a factor of 10 in the case of AT&T and a factor of 4 in the case of MCI. Virtually all of the error is from the assumption of constant elasticity of demand; the assumption of Stackelberg equilibrium turns out to be unimportant.[25]

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[25] The Baker-Bresnahan approach also requires individual-firm cost shifters as instruments, and this may be a significant drawback since good instruments are hard to find and weak instruments yield estimates with very large standard errors (see Froeb and Werden, 1991, 44–46).

Hausman, Leonard, and Zona (1994) also calculate the price effects of several beer mergers using an elasticity-estimation technique. They assume a multilevel almost ideal demand system (AIDS), and estimate a host of elasticities, using a panel of scanner data from supermarkets for various cities. Hausman (1994) applies the same techniques to predicting the effects of new products in the ready-to-eat cereal industry.

5. Conclusions

Structural merger policy leaves much to be desired, particularly when applied to differentiated products. As an alternative to focusing on market delineation and market shares, we suggest that the price and welfare effects of merger be simulated in standard, tractable oligopoly models. We propose the logit model, which has the great advantages of simplicity and parsimony of parameterization. The mathematical properties of the logit function not only assure a unique solution in theory, they also make it relatively simple to find it in practice. And the only inputs necessary for a simulation are market shares and prices premerger, and two demand parameters. We also believe that the logit assumption is the most reasonable one to make in the absence of either strong contrary prior beliefs or strong contrary empirical evidence.

A common reaction to the notion of logit merger simulations may be that the logit assumption is arbitrary and almost certainly wrong, and therefore, that the entire exercise is uninteresting. This reaction misses to point. Even if the logit assumption is incorrect, logit merger simulations still provide a starting point for discussion and analysis that is vastly superior to that provided by structural presumptions. A rough quantification of effects may be the best one can do in many cases, but under the best of circumstances simulations can provide reasonably reliable estimates of the actual effects of proposed mergers. That would be the case either if the data indicated that the logit assumption was approximately correct, or if some other demand system supported by the data were used instead.

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The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy

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Using the logit model, and assuming Nash equilibrium in prices and constant marginal cost, it is straightforward to estimate critical demand parameters and simulate mergers. In this way, the logit model can be used to predict the price and welfare effects of mergers. We explore the effects of mergers in this model both analytically and through simulations of hypothetical mergers of U.S. long distance carriers. We find that only mergers involving AT&T would be likely to lessen welfare significantly. Simulations such as these provide a firmer foundation for antitrust policy than traditional structural indicators. The logit model is not always appropriate, but the basic methodology can be adapted to other demand systems.

1. Introduction

The price and welfare effects of mergers in Cournot models with homogeneous products have been the subject of several analyses in recent years (for example, Farrell and Shapiro, 1990; McAfee and Williams, 1992; Werden, 1991). However, Bertrand models with differentiated products may be of greater relevance to antitrust policy. Few industries have a truly homogeneous product and only one price, and despite the insights of Kreps and Scheinkman (1983), there remain doubts about the quantity-setting assumption. In addition, the assumption of a noncooperative competitive interaction is more likely to be reasonable with differentiated products than with homogeneous products.[1]

The most notable studies on Bertrand mergers are those by Levy and Reitzes (1992) and Deneckere and Davidson (1985). Levy and Reitzes consid-

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1. We believe that the competitive interaction is likely to be noncooperative in most differentiated product industries, in part because product differentiation tends to make it more difficult to reach collusive agreements (unless it is straightforward to allocate customers or the like). We recognize, however, that some sort of collusion is widely thought to have occurred in some differentiated products industries, notably breakfast cereals and cigarettes.

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er a model of localized, spatial competition, with each firm competing directly with only the adjoining firms around a circle. Deneckere and Davidson consider a model of generalized competition with linear demand. Neither study provides useful guidance for merger policy by indicating how the price and welfare effects of mergers relate to market shares, demand elasticities, and other factors that can be assessed in an antitrust case.[2] This is partially due to the fact that both consider only the symmetric case, even though differentiated products industries are often highly asymmetric. Moreover, Levy and Reitzes consider strictly localized competition in a single dimension, which certainly is not typical.

We examine the price and welfare effects of Bertrand mergers in the context of a more appealing model of generalized competition—the logit model. Although the logit model has substantial limitations, it is of significant interest for several reasons. First, the logit model is simple enough to permit the derivation of analytic results, which significantly extend the work of Levy and Reitzes and Deneckere and Davidson. Second, the logit model has direct policy relevance, since the 1992 Horizontal Merger Guidelines use it as the base case for the analysis of mergers in differentiated products industries. The logit model is a base case in the sense that the merging firms are neither especially close in product space nor especially far apart.[3] Finally, the logit model is very practical for use in antitrust cases with limited data and severe time pressure.[4] The only inputs required for simulating mergers in our version of the logit model are market shares and prices, which can be easily observed, and two demand elasticity parameters, which can be fairly easily estimated using well established methods, or guessed at in a pinch.

Among the implications of this model are: The prices of all products in the industry increase as a result of a merger, but the magnitudes of the price increases are very different for different products. If the merging firms are of different size, their merger has asymmetric effects on their prices; the price of the smaller-share product is increased much more than that of the larger-share product. In addition, the merged firm typically increases the weighted average of its two prices much more than any nonmerging firm increases its price. Larger nonmerging firms increase price more than smaller ones, so increased concentration among the nonmerging firms increases the price effect of a merger, but the effect is typically fairly weak. Finally, mergers may enhance welfare even though they increase price, and increased concentration among the nonmerging firms may reduce the welfare loss from a merger, or even reverse it.

2. Deneckere and Davidson do offer a fairly general proof that prices increase as a result of Bertrand mergers in differentiated products industries. In another recent study, McElroy (1993) shows that it is possible for some prices to fall as a result of a Bertrand merger.

3. See U.S. Department of Justice and Federal Trade Commission (1992: § 2.21) and compare with Willig (1991: 299–304).

4. The law requires that the government be given just 30 days advance notice of mergers, and it may be infeasible to undo a merger after it is consummated.

To illustrate the application of the model, we analyze the price and welfare effects of mergers among existing U.S. long-distance carriers. We make two alternative assumptions concerning the effects of mergers on costs. One assumption is that mergers have no effect on costs, and this is probably the most reasonable assumption. Under this assumption, mergers involving AT&T have significant adverse welfare effects, and mergers not involving AT&T have much smaller welfare effects. The alternative cost assumption is that a merged firm has a marginal cost equal to the lesser of the two marginal costs of the merging firms. Under this assumption, all mergers of pairs of long-distance carriers enhance total welfare, except that of AT&T with MCI.

Section 2 presents our version of the logit model; Section 3 considers the effects of mergers in logit oligopoly on price and welfare; and Section 4 briefly examines the comparative static effects of changing the two demand elasticity parameters. Section 5 illustrates the application of the logit model to hypothetical mergers among U.S. long-distance carriers. Section 6 considers the limitations of the logit model and discusses alternatives. Section 7 offers a few observations on the Merger Guidelines' specific enforcement standards for differentiated products industries. Finally, Section 8 offers some concluding remarks.

2. Logit Oligopoly

A logit demand system generally is motivated by a random utility model in which consumers make a discrete choice among a set, C, of n alternatives, selecting the alternative yielding the greatest utility (see Ben-Akiva and Lerman, 1985: 55–57, 100–104; McFadden, 1974: 106–10). We consider a version of the model that specifies the indirect utility of consumer i associated with the choice of product j as

$$U_{ij} = a_j - \beta p_j + e_{ij}. \tag{1}$$

The price coefficient, β, is assumed to be constant for all consumers and products,[5] and all generally perceived quality differences among products are summarized by the a_j's. The disturbance term, e_{ij}, represents an individual-specific component of utility that is uncorrelated with price, p_j. If the e_{ij}'s are independently and identically distributed according to the extreme value distribution, the choice probabilities have the familiar logistic form (see Ben-Akiva and Lerman, 1985: 104–6; McFadden, 1974: 110–12):

$$\pi_j = \exp(aj - \beta p_j) / \sum_{k \in C} \exp(a_k - \beta p_k). \tag{2}$$

5. This formulation is appropriate only if price is appropriately normalized. For example, if different-size packages of detergent are alternative choices, price must be per unit of volume or weight, rather than per package.

For our purposes, it is more convenient to express the model in traditional antitrust terms. We define product n to reflect the choice of "none of the above" (i.e., to be the outside good) and we assume $p_n \equiv 0$ to make the utility of the outside good a constant. The vector of the remaining prices is denoted $\mathbf{p}$, and the share-weighted average premerger price for the inside goods is denoted $\bar{p}$. We term as "shares," denoted $\mathbf{s}$, the vector of choice probabilities for the "inside goods" (i.e., those other than the outside good), conditional on the choice being an inside good.

The (positive) own-price and cross-price elasticities of demand for particular inside goods, ϵ_j and ϵ_{jk}, are

$$\epsilon_j = \beta p_j(1 - \pi_j) = |\beta\bar{p}(1 - s_j) + \varepsilon s_j|p_j/\bar{p} \tag{3}$$

$$\epsilon_{jk} = \beta p_k \pi_k = s_k(\beta\bar{p} - \varepsilon)p_k/\bar{p}. \tag{4}$$

There is also an implied (positive) "aggregate elasticity of demand for the inside goods," specifically

$$r \equiv -|\partial\pi_i(\lambda\mathbf{p})/\partial\lambda||\bar{p}/\pi_i(\mathbf{p})| = \beta\bar{p}\pi_n, \tag{5}$$

where $\pi_i(\mathbf{p}) \equiv 1 - \pi_n(\mathbf{p})$ is the sum of the choice probabilities for the inside goods, λ is a scalar, and the derivative is evaluated at $\lambda = 1$.

The primitives of our version of the model, which completely characterize an industry, are shares, $\mathbf{s}$, and prices, $\mathbf{p}$, both of which can be observed, and the parameters ε and β, both of which can be estimated. Roughly speaking, β is the cross elasticity of demand parameter, controlling the substitutabilities among the inside goods; and ε is the aggregate elasticity of demand parameter, controlling the substitutability between the inside goods and the outside good.

There are several reasons for making ε rather than π_n a primitive of the model. First, economists are accustomed to dealing with demand elasticities, so the underpinnings of a merger simulation will be better understood if an assumption is made with respect to ε rather than π_n. Second, discrete choice models are not designed to estimate the implied aggregate demand elasticity. It is, therefore, preferable to estimate that elasticity using aggregate data and the corresponding econometric tools. We link the aggregate demand estimation with the discrete choice estimation by choosing the value for π_n that is consistent with the aggregate estimate of ε. In our model, π_n is not really a probability at all, but rather a scaling factor used to achieve this consistency.[6]

6. The conventional approach has been to let π_n be the actual probability of choosing none of the above and to place the remaining products in a nest to make the inside goods better substitutes for each other than the outside good is for them. This approach links in an undesirable way the aggregate elasticity of demand with the cross elasticities of demand within the nest. A change in the nesting parameter that makes products in the nest better substitutes for each other necessarily makes outside goods less good substitutes for the products in the nest.

Differences among the α_j's are all that matter, and they are unaffected by the arbitrary choice of one of them. Thus, we set α_n equal to an arbitrary constant, and calculate the α_j's for the inside goods in two steps. First, $\mathbf{s}$ is converted into a vector of π_j's:

$$\pi_n = \varepsilon/\beta\bar{p}, \qquad \varepsilon \in (0, \beta\bar{p}) \tag{6}$$

$$\pi_j = s_j(1 - \pi_n), \qquad j = 1, 2, \ldots, n - 1. \tag{7}$$

The logs of the ratios of π_j to π_n,

$$\ln(\pi_j/\pi_n) = \alpha_j - \alpha_n - \beta p_j, \tag{8}$$

are then solved for the α_j's, given α_n and $\mathbf{p}$.

To complete the model, we assume: each product is initially sold by a single firm; each firm has constant marginal cost, c_j; and there are no fixed costs. We also assume that the equilibrium is Nash in prices both pre- and postmerger. We also assume for the present that economies of scale and scope cannot be realized through merger. Finally, we assume that product characteristics other than price are fixed, so that a merger cannot result in any strategic effects other than those involving price. In particular, mergers cannot lead to entry, or to product repositioning by established firms.

Given these assumptions, each of the first-order conditions for profit maximization [Equation (14) below] can be solved uniquely for the implied value of c_j.[7] With all the demand and cost parameters, it is straightforward to calculate the effects of a merger on prices and shares by solving the postmerger first-order conditions for profit maximization.[8] Anderson and de Palma (1992) and Anderson, de Palma, and Thisse (1992: 264–66) have proved the existence and uniqueness of the equilibrium.

In logit models, the welfare effect of a change in any argument of the utility function is calculated as the compensating variation necessary to restore consumers to the original level of utility. As Small and Rosen (1981) have shown, the change in consumer welfare brought about by changing prices from $\mathbf{p}^0$ to $\mathbf{p}^1$ is given by[9]

7. For certain parameter values, negative marginal cost is implied by Equation (14) if a firm's share is sufficiently great. Negative marginal costs would cause mergers to have unrealistic welfare effects, so we assume throughout that all shares are small enough that all marginal costs are positive. With all product prices equal to unity, as we generally assume, avoiding negative marginal costs requires $\max[s_j] < (\beta - 1)/(\beta - \varepsilon)$, and there can be a negative marginal cost only if demand is inelastic.

8. As Berry (1994) notes, this must be done numerically. We do this calculation and all calculations using Mathematica. We would be happy to provide the Mathematica code upon request.

9. Raising one or more prices reduces this measure of change in consumer welfare as long as both the terms in square brackets in Equation (9) are positive. To assure that they are, we choose a large value for α_n.

Table 1 Price Increases for the Products of the Merged Firm Resulting from Mergers with a Combined Share for the Merging Firms of 40 Percent

Shares of the Merging Firms	Percentage Price Increase for the Smaller-Share Product	Percentage Price Increase for the Larger-Share Product	Share-Weighted Average Percentage Price Increase
1, 39	9.09	0.18	0.33
5, 35	7.88	0.93	1.57
10, 30	6.47	1.90	2.86
15, 25	5.19	2.92	3.71
20, 20	4.01	4.01	4.01

Note: For all mergers it is assumed that all premerger prices equal unity, $\beta = 5$, $\varepsilon = 1$, and there are two nonmerging firms with equal shares.

Even though all prices rise, the share-weighted industry average price may fall if higher priced products experience proportionately greater output reductions. Such would be the case if the merging firms had higher than average premerger prices. On the other hand, because all prices increase, it follows from Equation (9) that consumer welfare decreases as a result of a merger. Each firm's profits also increase as a result of a merger.

A merger leads to a reallocation of output from the merging firms to the nonmerging firms, because the nonmerging firms raise price less than the merged firm raises the weighted average of its two prices. If the nonmerging firms, on average, were larger than the merging firms, their costs would be lower or perceived quality higher, and this shift in relative outputs would enhance welfare. A merger would cause a net increase in welfare if the output reallocation were relatively large because of relatively high cross elasticities of demand (specifically $\beta\hat{p}$), and if there were relatively little substitution to the outside good because of a relatively low aggregate elasticity of demand.[12]

If the shares of the merged firm's products differ premerger, there is a shift in output from the product with the smaller premerger share to the product with the larger premerger share because the merged firm raises the price of the former product more than the price of the latter. Thus, the average cost of the merged firm is less than that of the merging firms or the perceived quality higher. A merger would cause a net increase in welfare if the output reallocation were relatively large because of relatively high cross elasticities of demand and a substantial inequality of the merging firms' shares, and if there were relatively little substitution to the outside good because of a relatively low industry elasticity of demand. Indeed, it is possible for mergers to enhance welfare even though they involve firms with a combined share in excess of 50 percent.[13]

12. As an example, the merger of two firms with shares of 10 percent enhances welfare if $\beta\hat{p} = 7$, $\varepsilon = 1$, and there is one nonmerging firm.

While either of the foregoing effects may cause a merger to produce a net increase in welfare, that is far more likely with the former effect. In particular, the former effect causes mergers to produce a net increase in welfare over a significantly larger range of the demand parameters. Both of the effects arise in Cournot models as well.[14] In the Cournot context, the only possible source of an efficiency gain from a merger is the exploitation of cost differences among firms. That is not the case with differentiated products because there are perceived quality differences, which also affect welfare.

In the logit context, larger firms generally are inferred to have both lower marginal costs and higher α_i's than their smaller counterparts, but that is not the case if larger firms have significantly higher prices. It is easy to see from Equation (14) that, with sufficiently high prices, larger firms would have higher costs despite higher markups. It might seem that the welfare effects of mergers must depend a great deal on premerger prices and inferred marginal costs and α_i's. That is not the case, however, because the effects of a merger on our measures of change in consumer welfare and change in total welfare are independent of premerger relative prices.[15] Holding $\mathbf{s}$, β, ε, and $\hat{p}$ constant, while changing individual prices, forces offsetting changes in the c_i's and the α_i's that maintain the premerger price–marginal cost margins and differences among the $(\alpha_i - \beta p_i)$'s. With the α_i's changing in this way, the postmerger first-order conditions are satisfied by the same markups and shares for any set of relative premerger prices, and premerger prices do not affect the welfare change calculations.

The effects of merger efficiencies in the form of cost reductions are easily incorporated into the analysis of a merger. If a merger would be expected to reduce one merging firm's marginal cost, then the simulations of the postmerger equilibrium can incorporate that assumption. One possibility we consider below is that the merged firm's marginal cost is equal to the lesser of the marginal costs of the two merging firms. Estimates of fixed cost savings are even more easily incorporated into the welfare calculations. Finally, it is possible in some instances to incorporate effects of mergers on perceived product quality, for example, if the estimated logit demand system has a linear function of product characteristics instead of just α_i constants. Any predict-

13. As an example, the merger of firms with shares of 45 and 10 percent enhances welfare if $\beta\hat{p} = 15$, $\varepsilon = .5$, and there is one nonmerging firm.

14. See Farrell and Shapiro (1990) and Werden (1991). The literature on Cournot models has not focused on shift of production from the merging firms to nonmerging firms as we do. The importance of these effects may be greater in a differentiated products model than in a homogeneous product Cournot model, because firm asymmetries may be greater. Cournot mergers also tend not to be privately profitable, but that is not the case for Bertrand mergers (see Deneckere and Davidson, 1985).

15. This statement no longer holds if mergers are assumed to reduce the marginal cost of the higher-cost merging firms to a level dependent on the marginal cost of the lower cost merging firm.

able effects of a merger on product characteristics could then easily be taken into account.

4. Comparative Statics Involving the Demand Elasticity Parameters

To facilitate the discussion in this section and the next, it is useful to introduce some additional notation to refer to the price and welfare effects resulting from a merger:

Δp_j = the percentage price increase for firm j

Δp_{Ind} = the share-weighted average percentage price increase for the industry

ΔCW = change in consumer welfare as a percentage of premerger revenue

ΔW = change in total welfare as a percentage of premerger revenue.

The comparative static effect of changing the demand elasticity parameters is of interest for the conventional reasons and also because it indicates the importance of uncertainty about the values of these parameters. If the estimates are very sensitive to small changes in parameter values, precise estimates of parameter values are important, and if the reverse is true, rough estimates or guesses are satisfactory. Unfortunately, it is not possible to derive analytically general comparative static results relating to the magnitudes of the effects of changing parameter values.[16] Nevertheless, it appears from numerous simulations that the effect of changing the demand elasticity parameters is very much the same on Δp_m, Δp_{Ind}, and ΔCW, and is quite consistent from one merger to the next.

For various parameter values, Table 2 gives the effect on Δp_{Ind} of the merger of two firms with shares of 20 percent, assuming two nonmerging firms with equal shares. The figures in the table are relative to those for a base case of $\beta\bar{p} = 5$ and $\varepsilon = 1$.[17] The relative effects of the merger on ΔCW are almost exactly the same, and the effects on Δp_m are approximately the same. Moreover, for a large number of other mergers we have examined, the relative effects are approximately the same as those presented in Table 2.

There are three notable features of Table 2. First, the effects of mergers are more sensitive to changes in ε than to changes in $\beta\bar{p}$. Second, if either $\beta\bar{p}$ or ε is high, the effect of changing the other is rather modest. Thus, if either of the parameters is known to be high, uncertainty about the other is of limited importance. Third, Δp_m, Δp_{Ind}, and ΔCW are not monotonic in $\beta\bar{p}$; all three peak between $\beta\bar{p} = 4.3$ and $\beta\bar{p} = 4.6$. The reason for this is straightforward. If $\beta\bar{p}$ is very large, the inside goods are such good substitutes for each other that a merger matters little, and if $\beta\bar{p}$ is very small, the inside goods are such poor substitutes for each other that a merger matters very little. Consequently, the effect of a merger must be greatest at some intermediate value of $\beta\bar{p}$.

16. It can be shown analytically that multiplying both β and ε by the same positive constant has the effect of multiplying the price and welfare effects of mergers by the reciprocal of that constant.

17. These parameter values are not arbitrarily chosen. The empirically based value of $\beta\bar{p}$ used in the next section is roughly 4.8, and unitary demand elasticity is in the range of many empirical estimates.

Table 2 Relative Effects of Mergers on Δp_{Ind} with Various Values of β and ε

β \ ε	0.5	1	2	4
2.5	2.00	1.31	0.38	
5.0	1.24	1.00	0.65	0.19
7.5	0.89	0.76	0.58	0.32
10.0	0.70	0.62	0.50	0.33

ΔW is not considered in Table 2 because the effect of changing parameter values is quite different on ΔW than on Δp_m, Δp_{Ind}, and ΔCW, and because the effect of changing parameter values is not consistent from one merger to the next. Within the range of parameter values considered, ΔW is not monotonic in either $\beta\bar{p}$ or ε. For the merger considered in Table 2, if $\beta\bar{p} = 5$, the maximum welfare loss occurs at $\varepsilon = 1.97$. If $\varepsilon = 1.97$, the maximum welfare loss occurs at $\beta\bar{p} = 3.22$. If both parameters are allowed to vary (and all marginal costs must be positive), the maximum welfare loss occurs at $\beta\bar{p} = 1.25$, $\varepsilon = 0.43$. ΔW is not monotonic in ε because the profit increase from mergers rises much more rapidly as ε is decreased than ΔCW decreases.

5. Calculated Price and Welfare Effects of Mergers among U.S. Long-Distance Carriers

To illustrate both the process of simulating mergers with a logit model and the sort of predictions that flow from the logit model, we consider hypothetical mergers among existing U.S. long-distance carriers. There are three major long-distance carriers in the United States—AT&T, MCI, and Sprint—all serving throughout the nation. In 1991, they accounted for 87 percent of the long distance revenues. The remaining 13 percent of revenue was divided among roughly 500 minor carriers, most of which operate in only a small fraction of the U.S., and no one of which accounted for as much as 1 percent of industry revenues. For the purposes of estimating the effects of hypothetical mergers, we assume that choice set faced by any particular subscriber consists of the three major carriers and three of the many minor carriers, assumed to have equal shares.

For market shares, we use actual 1991 nationwide shares of minutes of usage.[18] For prices, we use actual July 1991 average revenue per minute.[19] We take ε to be 0.7, which is in the range of widely cited, published estimates

18. The raw data are from Federal Communications Commission, *Statistics of Communications Common Carriers*, 1991/1992 ed., which reports revenues. The revenue shares are: AT&T, 62.2 percent; MCI, 15.0 percent; Sprint, 9.7 percent; all others, 13.1 percent. We convert these into minutes shares using the average price data. The minutes shares we use are: AT&T, 61.4 percent; MCI, 15.5 percent; Sprint, 9.8 percent; each of the three minor carriers, 4.4 percent.

19. The price data were supplied by Michael Ward and are for five south central states. The average revenues in cents per minute are: AT&T, 16.6; MCI, 15.9; Sprint, 16.2. We have no price data for the minor carriers and assume that their average price was the same as Sprint's.

Table 3 Calculated Price and Welfare Effects of Possible Mergers Assuming that Mergers Do Not Affect Marginal Costs

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T MCI	4 87	25 70	0 49	0 21	5 06	−5.63	−2 296
AT&T Sprint	2 90	0 48	24 42	0 12	2 82	−3 40	−1 243
AT&T Minor	1 22	0 20	0 12	23 82, 0 05	1 18	−1 45	−0.488
MCI Sprint	0 58	2 10	3 35	0 03	1 01	−0 98	−0 046
MCI Minor	0 25	0 89	0 03	3.28, 0 02	0 44	−0 43	−0 011
Sprint Minor	0 16	0 04	0 85	1 96, 0 01	0 27	−0 27	−0 0003
Minor Minor	0 07	0 02	0 01	0 84, 0 00	0 12	−0 12	0 003

Note For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firm(s)

of the elasticity of demand for long-distance service (see Taylor, 1980: 170; and Taylor, 1993). We use an estimate of β derived from a proprietary study of intra-LATA (Local Access Transport Area) carrier choice based on a survey of choices in hypothetical situations, so β could be estimated without instrumental variables. What matters for the welfare effects of mergers is $\beta\hat{p}$, and a β of 29 with the prices we use gives roughly the same value of $\beta\hat{p}$ as in the proprietary study.[20]

Table 3 presents the calculated price and welfare effects for all possible mergers among the carriers, assuming that costs are unaffected by mergers. A striking feature of these results is the substantial asymmetry of the price increases between the two merging firms and between the merging and nonmerging firms. For the mergers involving firms of very different size—those involving AT&T and those between MCI or Sprint and a minor firm—the smaller merging firm increases price at least several times as much as the larger merging firm. For all of the mergers, the nonmerging firms increase price by a fraction of the amount that the larger merging firm increases price.

The merger of two minor firms actually enhances total welfare slightly, and the remaining mergers not involving AT&T lessen welfare very little; even the MCI–Sprint merger reduces welfare by less than 0.05 percent of premerger revenues. Mergers not involving AT&T have such small effects on welfare because AT&T's very large share implies that it has a combination of cost and perceived quality advantages over its rivals,[21] so the substitution to AT&T induced by mergers of its rivals has a welfare-enhancing effect. Mergers involving AT&T are far less likely to be welfare enhancing. As noted above, shifts in production between two merging firms are less likely to cause mergers to enhance welfare than are shifts in production from the merging firms to the nonmerging firms.

20 Additional parameter values within the confidence interval of $\beta\hat{p}$ are considered in Froeb, Werden, and Tardiff (1993).

21 As explained above, it does not matter for the welfare calculations whether the advantage is in cost or perceived quality.

Table 4. Calculated Price and Welfare Effects of Possible Mergers with Non-AT&T Carriers in a Nest, Assuming that Mergers Do Not Affect Marginal Costs

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T–MCI	3 71	17.34	0 84	0 36	3 89	−4 22	−1 546
AT&T–Sprint	2.20	0.85	16 69	0.21	2 19	−2 59	−0 762
AT&T–Minor	0 92	0.35	0.20	16.48, 0 09	0 91	−1 10	−0 274
MCI–Sprint	0 77	2.84	4.49	0.13	1 33	−1 30	0 012
MCI–Minor	0 32	1.14	0.12	4.19, 0 05	0 56	−0 55	0 024
Sprint–Minor	0.20	0.13	1.03	2.39, 0 03	0 34	−0 34	0 030
Minor–Minor	0.09	0.06	0 03	0.98, 0 01	0 15	−0.15	0 018

Note For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firm(s)

It has been suggested that consumers perceive non-AT&T carriers as especially close substitutes for each other. Thus, the proper specification of demand may be a nested-logit model, with the non-AT&T carriers in a nest. We do not know what value of the nest parameter would be appropriate, and arbitrarily choose 0.7 so we can illustrate the effects of adding a nest. As Table 4 shows, all mergers not involving AT&T enhance welfare. Adding the nest makes the non-AT&T firms closer substitutes and thus introduces greater competition. This causes mergers not involving AT&T to have greater price effects. Introducing a nest also affects the inferred marginal costs and α's, and these effects cause the mergers not involving AT&T to be welfare enhancing. With lower nest parameter values, the welfare gain from these mergers is even greater.

Finally, we consider the possibility that the cost advantages of large firms can be extended through merger. Table 5 presents the calculated price and welfare effects of the mergers under that assumption, using the simple logit model. All the mergers except AT&T–MCI enhance welfare although the

Table 5. Calculated Price and Welfare Effects of Possible Mergers Assuming the Cost Advantages of Large Firms Can be Extended Through Merger

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T–MCI	5 95	10 96	0 44	0.19	4 92	−5 06	−0 587
AT&T–Sprint	3.77	0 41	6 33	0 10	2 75	−2 91	0 130
AT&T–Minor	1 64	0 16	0 10	4 14, 0 04	1 15	−1 21	0 162
MCI–Sprint	0 33	2 35	0 14	0 02	0 59	−0 56	0 306
MCI–Minor	0 10	1 04	0 01	−1 14, 0 01	0 18	−0 20	0 195
Sprint–Minor	0 12	0 03	0 89	0 89, 0 01	0 20	−0 20	0 047
Minor–Minor	0 07	0 02	0 01	0 84, 0 004	0 12	−0 13	0 003

Note For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firm(s)

welfare gains are all small. The welfare effects of the mergers are much more favorable in this case not only because of the direct effect of the cost savings from the mergers of different-sized firms. Also important is the indirect effect the cost reduction has on the price increases resulting from the mergers. The smaller-share merging firm generally raises price a great deal under the assumption that marginal costs are unaffected by merger. Under the assumption that the marginal cost of the smaller-share merging firm is reduced to that of the larger-share merging firm, the reduction in the marginal cost of the smaller-share merging firm causes its price to be increased far less. If MCI were to merge with a minor firm, the marginal cost reduction for the product of the minor firm would be sufficiently great that the merged firm would reduce the price for the minor firm's product.

6. Limitations of the Logit Model and Alternative Models

The logit model is based on the restrictive assumption known as Independence of Irrelevant Alternatives (IIA) (see Ben-Akiva and Lerman, 1985: 108–11). This assumption implies that when the price of one product is increased, consumers switch to others in proportion to the relative shares of those products. Actual preferences, however, may yield very different substitution patterns because certain goods may be viewed as closer substitutes than others. For example, in response to a price increase for BMWs, the IIA assumption implies that much of the substitution will be to top-selling models like Ford Taurus and Honda Accord and very little to models sold by Acura, Cadillac, Lincoln, and Mercedes Benz, which have much smaller shares. We suspect that the IIA assumption does not hold in this situation.

The logit model is easily generalized by the incorporation of nests, as we did above. In the car example, there could be a nest for luxury cars and a nest within that nest for foreign or German luxury cars. This certainly makes the logit model more general, but it is still restrictive in two senses. The IIA assumption still applies within a nest and between nests. In addition, a single nest parameter controls how close the goods in a nest are as substitutes for each other and how close they all are as substitutes for goods outside the nest. This means, for example, that making goods in a nest better substitutes for each other requires making them worse substitutes for all other goods. Finally, Brownstone and Small (1989) find that a common estimation technique used for the nested logit is both unstable and inefficient, and yields biased standard errors.

Whether the logit model—simple or nested—fits a particular data set can be examined through an explicit test of the IIA assumption. The leading test was derived by Hausman and McFadden (1984). Its application and the application of alternative tests are discussed by Ben-Akiva and Lerman (1985: 183–94). The IIA assumption has been rejected as a null hypothesis by some empirical studies, but it has been accepted by others (for example, Ben-Akiva and Lerman). When the IIA assumption is not rejected by the data, the logit model can be considered to be a reasonable approximation.

We believe that it is always useful and appropriate to supplement the traditional, structural analysis of mergers in differentiated products industries with simulations. As we discuss presently, logit is not the only possible model and another model may be preferable. We would not hesitate, however, to use the logit model whenever a lack of time or money effectively foreclosed other options. Unlike other modeling approaches, the logit model with our parameterization requires very little information—just readily observable prices and shares, and two demand elasticity parameters, which can be guessed at in a pinch. Even when the logit model is not strictly applicable and the specific predictions of logit simulations cannot be considered reliable, logit simulations provide much needed perspective. They indicate asymmetries in, and order of magnitude of, the price effects of mergers, and they provide a basis for trading off possible cost savings against price increases.

One alternative to using the logit model is to assume that all of the relevant elasticities are invariant to the price and quantity changes resulting from a merger. With this strong assumption, the effects of a merger are easily calculated from postmerger first-order conditions and elasticities. One notable example of this approach is Baker and Bresnahan (1985). They calculate the price effects of several beer mergers using estimated residual demand elasticities. Their approach assumes that elasticities are constant and that the merged firm acts as a Stackelberg leader. Although this approach has the advantage of requiring the estimation of very few elasticity parameters, it still requires some individual-firm cost shifters as instruments. This may be a significant drawback since good instruments are hard to find and weak instruments yield estimates with very large standard errors (see Froeb and Werden, 1991: 44–46).

Most significantly, the assumption of price-invariant elasticities is not tested, and it is unlikely to hold. Most often, increasing the price for a product increases the elasticity of its demand. There is a strong tendency for this to occur, because the price increase induces a quantity decrease, and both of these effects tend to increase the demand elasticity. If the elasticity of demand does increase as price is increased, assuming the contrary leads to an overestimate of the price increases from mergers. Froeb and Werden (1992) explore this phenomenon, and illustrate its significance. As a further illustration, consider the merger of AT&T with MCI, assuming logit demand. The percentage price increases calculated using the Baker-Bresnahan approach are 48.6 for AT&T and 101.8 for MCI.[22] These estimates exceed the actual figures in Table 3 by a factor of 10 in the case of AT&T and a factor of 4 in the case of MCI.[23] Virtually all of the error arises from the assumption of constant elasticity of demand; the assumption of Stackelberg equilibrium turns out to be unimportant.

Hausman, Leonard, and Zona (1994) also calculate the price effects of sev-

22. The calculations involve dividing both sides of Equation (14) by p_j, evaluating the right-hand side at premerger prices, then solving for p_j.

23. The margins of error are smaller for the other mergers and quite small when the price increases predicted by the logit simulations are very small.

eral beer mergers. They assume a multilevel, almost ideal demand system (AIDS), and estimate a host of elasticities, using a panel of scanner data from supermarkets for various cities. To identify the parameters of the demand system, they assume that costs are the same across cities and that demand is independent across cities. This allows them to use prices in one city as an instrument for price in each other city, thus avoiding problems associated with using cost shifters as instruments, and making it possible to use high-frequency scanner data, which may be superior to alternatives. However, the assumption of demand independence across cities is likely to be violated for products, including beer, that have significant seasonal effects or have special promotions at the same time in many cities. In addition, they assume that elasticities are constant in estimating the effects of a merger.

A very different approach has been taken by Berry (1994) and Berry, Levinsohn, and Pakes (1993). They also use panel data, but their data are for various models of products like automobiles, and consumers are assumed to base their choices on observable product characteristics (or on unobservable attributes correlated with observable characteristics). Rather than assuming that elasticities are invariant to changes in prices and quantities, this approach exploits the fact that they do vary. A given product's equilibrium price is affected by variation in the characteristics of competing products, provided that the first product's equilibrium demand elasticity changes. Thus, the model is identified by using characteristics of competing products as instruments.

This approach assumes that characteristics of competing products are independent of demand shocks. This assumption is difficult to test, and it is likely to be violated if firms compete on the basis of model characteristics. This approach is similar to ours in that it uses first-order equilibrium conditions to estimate marginal costs. This line of research was only recently begun and has not yet been applied to mergers, but such an application would be a logical step.

Another solution to the identification problem, and the one used to generate the estimate of the cross elasticity parameter used in the simulations of long-distance carrier mergers, is to use hypothetical choice data rather than actual choice data. Hypothetical choice data are generated by asking consumers what choices they would make at specified prices. Specifying exogenous price variation obviates the need for any instruments. It also eliminates the need to extrapolate outside the range of observations, which is typically required with data on actual choices and can lead to significant error in estimation (see Froeb and Werden, 1991: 39; Froeb and Werden, 1992: 243–46). Furthermore, a consumer survey can be designed so that the right-hand-side variables are orthogonal. When that is the case, White (1980) has shown that a specific functional form, such as the logit, can be motivated as a first-order approximation to the unknown true function.

7. The Structural Standards of the Merger Guidelines

The 1992 Merger Guidelines state the specific enforcement standards used by the two federal antitrust enforcement agencies—the U.S. Department of Justice and the Federal Trade Commission. The general enforcement standards are based on two concentration measures[24]—the *increase in the HHI*, defined as twice the product of the shares of the merging firms, and the *postmerger HHI*, defined as the Herfindahl-Hirschman Index (HHI) for the relevant market plus the increase in the HHI. Mergers fall in a safe harbor if the postmerger HHI for the relevant market is at most 1,000 or the increase in the HHI is at most 50. If the postmerger HHI exceeds 1,800, the 1992 Guidelines (§ 1.51) "presume that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power," but they provide that this presumption may be overcome by any of a number of other factors they discuss in later sections, including one on product differentiation.

Section 2.21 of the 1992 Guidelines articulates a special enforcement standard for mergers in differentiated products industries. Under that standard, a merger is presumed to harm consumers significantly if the combined share of the merging firms is at least 35 percent. By negative implication, one may infer that a merger will be presumed not to harm consumers significantly if the combined share of the merging firms is below 35 percent. Typically, a combined share for the merging firms of 35 percent translates into a change in the HHI of 400–500 points, which is far in excess of the 100-point threshold of the general standard.[25]

The foregoing analysis suggests several observations about these standards.[26] First, a standard based on the combined share of the merging firms is problematic because the price and welfare effects of mergers vary greatly for a given combined market share. This is illustrated in Table 1, in which all the mergers have the same combined share for the merging firms. A far better measure for use as a structural standard would have been the product of the shares of the merging firms or, equivalently, the change in the HHI.

The overall level of concentration, holding the shares of the merging firms constant, is a relevant factor since the nonmerging firms increase price more the greater the concentration among them. On the other hand, this effect is rather small, and greater concentration among the merging firms gives rise to a welfare gain from the reallocation or production. The net effect of an increase in concentration among the nonmerging firms, holding the shares of

24. These concentration measures are not meant to be predictions about the actual shares and concentration that will prevail postmerger (see Werden, 1991: 1002–3).

25. The section on mergers in differentiated products industries was just added in the 1992 edition of the Guidelines. At the same time, a 35 percent test was added (in § 2.22) for mergers in homogeneous goods industries, when the effect of concern does not involve coordination (i.e., when the effect is that in a Cournot model). There is no similar test when the effect of concern does involve coordination (i.e., when it stems from explicit collusion or some sort of repeated game equilibrium). Thus, the 1992 Guidelines must reflect a conscious decision to reduce the range of mergers subject to challenge on the basis of effects termed "unilateral," that is, effects not arising from coordination. This is curious because noncooperative models such as Cournot and Bertrand offer a far firmer basis for merger policy than does any notion of collusion (see Hay and Werden, 1993).

26. There is a much more extensive discussion on this subject in Werden and Froeb (1993).

the merging firms constant, is likely to be to mitigate the adverse welfare effects of a merger, and it can even reverse them.

Most importantly, if the logit model, which motivates the Guidelines' discussion of mergers in differentiated products industries, is appropriate, then it is far better to simulate the effects of a merger using that model than to rely on simple structural indicators. Simulations are more accurate generally; they identify asymmetric price effects; they identify possible welfare gains from production reallocation; and they provide a means of trading-off possible merger efficiencies. The last point is particularly significant because trading off price effects and possible efficiencies is a hopeless task if price effects are simply proxied for by market shares.

8. Conclusions

Economists have long been critical of the practice in antitrust law of predicting the competitive effects of mergers on the basis of shares of a delineated relevant market.[27] Early critics of this practice were advocates of monopolistic competition theories, and the argument that market shares are inadequate predictors is strongest in differentiated products industries. As Edward Chamberlin (1950: 86–87) put it:

> "Industry" or "commodity" boundaries are a snare and a delusion—in the highest degree arbitrarily drawn, and, wherever drawn, establishing at once wholly false implications both as to competition of substitutes within their limits, which supposedly stops at their borders, and as to the possibility of ruling on the presence or absence of oligopolistic forces by the simple device of counting the number of producers included.[28]

These criticisms are well taken, and they can be addressed by replacing the traditional structural approach with simulations of the effects of mergers within the context of a specified oligopoly model. We consider the logit model, but other models can also be used. Our version of the logit model is specifically designed to capture one of the important factors to which Chamberlin refers—competition from products outside the designated group. More generally, simulations capture the other factor to which Chamberlin refers—the oligopolistic interaction within the designated group. Taking cost differences and consumer preferences into account, simulations predict the complex, asymmetric price effects of mergers in differentiated products industries. Simulations also indicate effects on welfare of production reallocation induced by mergers, and they make it straightforward to incorporate reductions in fixed or marginal costs in an explicit welfare analysis.

Simulating the effects of mergers unfortunately requires undertaking something like market delineation, because it is necessary to impose some structure, such as delineating a set of inside goods. The simulations are affected by the delineation of this set because the inside substitutabilities are different from those between the inside and outside goods. On the other hand, narrowing the set of inside goods increases the aggregate elasticity of demand for the inside goods (and possibly the estimated cross elasticity parameter as well), so the simulations may not be very sensitive to the market delineation.

The logit model used here is a reasonable approximation to the structure of demand in some differentiated products industries. Our version of the logit model is also very practical. The two demand elasticity parameters can be easily estimated, or guessed at in a pinch, and premerger prices and market shares are the only other information required for simulations. Thus, we offer a simple, low-cost way in which to get some idea of the effects of mergers in differentiated products industries. The logit model can always be used to obtain a "quick and dirty" estimate, and it is possible to test whether the model is a good approximation to the actual demand system.

There are many situations in which the logit model is not appropriate. A nested logit model may be used in such cases, as may a probit model. In either case, estimation and simulation are more difficult, but still possible. Berry (1994) and Berry, Levinsohn, and Pakes (1993) employ far more complicated models, and such models may also be used to simulate the effects of mergers. These models may prove preferable to the logit model, but their advantages and disadvantages remain to be explored.

27. This practice in merger cases can be traced to the Supreme Court's 1948 *Columbia Steel* decision. Economists began expressing opposition to the practice in 1934 (see Werden, 1992: 125–29).

28. Much the same argument was made recently by Fisher (1987: 27), and Hausman, Leonard, and Zona (1992) make a related argument based on the Lerner index.

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